Odontogenic bacteremia following tooth cleaning procedures in children

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Abstract

Purpose: *This study was designed to investigate the prevalence and intensity of odontogenic bacteremia from tooth cleaning procedures in children and adolescents.*

Methods: *One hundred and fifty five children receiving dental treatment under general anesthesia at The Great Ormond Street Hospital for Children and Guy's Hospital were recruited. Each child was randomly allocated to one of three tooth cleaning groups. These were (1) toothbrushing, (2) professional cleaning with a rubber cup and (3) scaling.*

Results: *There was no significant difference in the prevalence of positive blood cultures or intensity of bacteremia between the three groups. The bacterial species isolated were similar to those reported by other workers. These were S. mitis, S. sanguis and Coagulase – negative staphylococci, all of which are implicated in the pathogenesis of Bacterial Endocarditis.*

Conclusions: *Patients at risk are as likely to develop odontogenic bacteremia from toothbrushing at home as from professional scaling and polishing of the teeth at dental surgery. (Pediatr Dent 22:96-100, 2000)*

Odontogenic bacteremia, particularly following the extraction of a tooth, is believed to be an important cause of bacterial endocarditis. As a consequence, it is recommended that patients with cardiovascular disease undergoing dental extraction should receive prophylactic antibiotics.[1,2,3] The guidelines of the Endocarditis Working Party (EWP) of the British Society of Antimicrobial chemotherapy provide specific guidance for antibiotic prophylaxis. This should be administered prior to extractions, periodontal surgery, and scaling.[1] By implication, there is no need for antibiotic prophylaxis to be given for other operative procedures. This creates a dilemma for pediatric dentists as it is known from clinical experience that other quasi-operative procedures also cause minor gingival bleeding. More than 20 years ago one group of workers demonstrated that 28% of children exhibited a detectable bacteremia following a simple dental prophylaxis (cleaning with a small rubber polishing cup).[4] The most recent (1994) American Heart Association guidelines(AHA) recommend antibiotic prophylaxis where bleeding is anticipated.[3] The current recommendations of the EWP in the United Kingdom do not specifically include cleaning procedures, apart from scaling, as procedures that require antibiotic prophylaxis. A further difficulty is the relationship between cleaning procedures in the home and odontogenic bacteremia. It has been known for many years that toothbrushing[5,6] and dental flossing[7] also cause a detectable bacteremia.

The difficulty for pediatric dental surgeons is to know whether the advice to provide antibiotic prophylaxis for just "scaling" is justified, particularly when bacteremia from other cleaning procedures may be equal to, or even greater than the bacteremia caused by scaling. The purpose of this work was to investigate the prevalence and intensity of odontogenic bacteremia from cleaning procedures in children and adolescents.

Patients and methods

Selection of subjects for the study

The subjects were children referred to Guy's Dental Hospital or The Great Ormond Street Hospital For Children (GOS) for dental treatment under general anesthesia between 1991 and 1994. The project was approved by the ethical committees of both hospitals. Written consent was obtained from the parents and also from children considered old enough to understand. Exclusion criteria were antibiotics within the previous month, hemorrhagic disorders and known viral carriage.

Procedures

Anesthesia was induced by the use of intravenous thiopentone or propofol, or by the inhalation of halothane with oxygen and nitrous oxide. The skin of the antecubital fossa of either the left or the right arm was prepared using 1% Povidone-Iodine solution. An intravenous cannula was inserted into a vein using standard aseptic technique. Following anesthesia, the distribution of bacterial dental plaque and gingivitis were assessed using a modification of the method of O'Leary.[8] This comprised dividing the tooth into 4 quadrisections, namely mesiobuccal, distobuccal, distolingual and mesiolingual. For each of these surfaces, plaque was assessed as either absent (code 0) or present (code 1) In this way each tooth had a maximum plaque score of 4. The assessments for gingivitis were recorded in a similar manner. These simplified indices are reproducible

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Table 1. Mean Plaque and Gingivitis Scores for Baseline and Each Cleaning Procedure

	Cleaning Procedure			
Baseline	**Mean**	**Median**	**Min**	**Max**
Plaque	10 ± 18.9	2	0	84
Gingivitis	3.3 ± 7.9	0	0	48
Toothbrushing	**Mean**	**Median**	**Min**	**Max**
Plaque	18 ± 21.6	12	0	96
Gingivitis	13 ± 20.4	6	0	96
Dental Cleaning	**Mean**	**Median**	**Min**	**Max**
Plaque	14 ± 12.7	10	0	68
Gingivitis	11 ± 13.6	8	0	68
Scaling	**Mean**	**Median**	**Min**	**Max**
Plaque	11 ± 7.9	12	0	24
Gingivitis	8 ± 7.7	6	0	28

in small children.[9] Spontaneous gingival bleeding was also recorded.

The procedures investigated are shown in Table 1. These are all tooth cleaning procedures which are either carried out by the patient at home or by the dental surgeon as part of the regular care provided to children.

A random number table was used to allocate each child either to a procedure, or to a baseline group with no procedure. The procedures investigated were toothbrushing (home care procedure), dental polishing using a handpiece with a rubber cup and scaling (both of which are iatrogenic procedures). As healthy children do not have periodontal pocketing and rarely accumulate calculus, a simulated scaling procedure was used. A scaler was introduced into the gingival crevice and manipulated in a way similar to that required to remove any debris. This often caused some bleeding. A single 8ml blood sample was taken from each patient 30 seconds[10] after the procedure. The baseline samples were taken before any dento-gingival manipulation was carried out[11] (Table 1). As soon as the blood sample had been taken, the dental treatment required was completed.

Microbiological methods

Two commercial broth culture systems were used; the Bactec 460 radiometric system (Guy's) and the Bactec 760 (GOS). (BACTEC, Beckton Dickinson UK Ltd., Oxford, OX4 3LY United Kingdom) A 3ml volume of blood was inoculated into each of the aerobic and the anerobic bottles.[12] Bacteria were identified using standard laboratory methods and the oral streptococci were further identified using API Strep 20.[13] (API Strep 20, Bio Merieux UK Ltd., Basingstoke, RG2 6HY United Kingdom.) The results were expressed as the percentage of samples which were positive.

A further 1.5 ml was inoculated into the Isolator system vial.[14] [Isolator Pediatric Merck (UK) Ltd. Poole Dorset. BH12 4NN]. This system estimates the intensity of bacteremia by lysis centrifugation, and gives the number of colony forming units per millilitre of blood (Isolator).

Data analysis

The data was tested for normality using the Shapiro-Wilk test[15] and found to be not normally distributed. Comparisons between the procedure groups were made using the Kruskall-Wallis test. The statistical software was Stata.[16]

Results

The results are expressed as the percentage prevalence of positive blood cultures, (Table 1) and the intensity of bacteremia as colony forming units per millilitre [cfu/ml] (Table 2). The organisms isolated were identified to genus level and to species level for oral streptococci[17] (Table 3).

Subjects

A total of 155 children were recruited to the study: 79 boys, and 76 girls aged 21 months to 16 years, 11 months. There were 50 subjects in the control group (no cleaning procedures), 52 subjects in the toothbrushing group, 53 subjects in the professional cleaning group and 50 subjects in the scaling group (Table 1). Anesthesia was induced by intravenous thiopentone or propofol in 228 patients (87%) and inhalation of halothane with oxygen and nitrous oxide in a further 20 children (13%).

Bacterial plaque and gingivitis scores

The mean bacterial plaque score and the mean gingivitis score for each are shown in Table 1. For the baseline group the mean plaque score was 10±18.9 and the mean gingivitis score, 3±7.9. In the toothbrushing group the mean plaque and gingivitis scores were 18±21 and 13±20.4, respectively. For the professional group the mean plaque and gingivitis scores were 14±12.7 and 11±13.6. For the scaling group the mean plaque score was 11±7.9 and the mean gingivitis score was 8±7.7. There was no spontaneous gingival bleeding, but there was some bleeding as a result of the simulated scaling. There was an association between the plaque and gingivitis scores, although this was not statistically significant.

Table 2. Percentage Prevalence of Bacteraemia Following Dental Cleaning Procedures Used in Children

Baseline (N=50)	**% Bacteraemia**
No cleaning procedures (data from Roberts et al. 1998a)	4 / 50=8.0%
Home Care Procedures (N=52)	**% Bacteraemia**
Toothbrushing	20 / 52=39.0%
Dental flossing (data from De Leo et al. 1974)	6 / 7=86.0%
Iatrogenic Procedures (N=51 in each group)	**% Bacteraemia**
Dental polishing	13 / 53=25.0%
Dental scaling	20 / 50=40.0%
Dental extractions (data from Roberts et al. 1998b)	17 / 44=39.0%
%=Percentage Prevalence of Bacteraemia (BACTEC)	

Chi Square 3.623, df=3, *P*=0.305 not significant. (Excluding dental flossing).
Chi Square 3.623, df=2, *P*=0.305 not significant. (Excluding dental flossing & extractions).

Table 3. Intensity of Bacteremia (cfu/ml blood) Following Cleaning Procedures in Children

Baseline	Mean	Range
No Cleaning Procedures	0	-
Home care procedures	**Mean**	**Range**
Toothbrushing	32.2±231	0-1666
Dental Flossing	no data	
Iatrogenic procedures	**Mean**	**Range**
Dental Polishing	15.9±83.5	0-557
Dental Scaling	2.2±13.2	0-93
Dental Extractions (data from Roberts et al. 1998)	0.23±0.8	0-4

Kruskall-Wallis test : Equality of Populations. Chi Square 0.039, df=2, *P*= 0.9807.

Positive blood cultures

There was no statistically significant difference in the number of positive blood samples in the groups studied (Table 2). The data for the control group is from an earlier study in which 8% of the blood cultures were positive,[11] 39% in the toothbrushing group, 25% in the dental polishing group and 40% in the dental scaling group. Data is included for dental flossing, which is from a separate investigation.[4]

Intensity of bacteremia

The intensity of bacteremia in colony forming units per millilitre of blood is shown in Table 2. There was no significant difference in the intensity of bacteremia in any of the three cleaning groups. The intensity of bacteremia for the control group was found to be 0 using the Isolator (Table 3). Data for dental extractions from an earlier investigation are included in the table.[18]

Bacteria isolated

These were similar to bacteria isolated from blood cultures following dental operative procedures.[6,18] These included *S. mitis*, *S. sanguis* and Coagulase-negative *staphylococci* (Table 4). The bacteria isolated from the baseline group included *S. sanguis*, Coagulase negative *staphylococci,* and *Oerskovia* species.

Discussion

The purpose of this study was to investigate the prevalence and intensity of odontogenic bacteremia from tooth cleaning procedures in children and adolescents, thus exploring the paradox of antibiotic prophylaxis for dental scaling. Three tooth cleaning procedures were investigated: toothbrushing, professional polishing, and scaling. Eight percent of the blood cultures in the baseline group were positive, but the intensity using the Isolator was recorded as 0. This suggests a lack of sensitivity of this system compared with other types of blood culture systems. There was no significant difference in the percentage prevalence of bacteremia or the intensity of bacteremia following the three cleaning methods. There was also no difference in the type of bacterial species isolated from the blood between the three groups. These included *S. mitis*, *S. sanguis,* and Coagulase-negative staphylococci, all of which have been isolated from blood cultures following dental operative procedures.[6,18] They are also implicated in the etiology of BE.[19,20] According to the guidelines of the EWP, antibiotic prophylaxis is only required for scaling. From the results presented here, patients at risk are as likely to develop a bacteremia from toothbrushing at home or from tooth polishing in the dental surgery. This could lead to BE in susceptible individuals. The association between the plaque and gingivitis scores was not statistically significant, which differs from other investigations. An explanation for this is that young children do not have periodontal disease and a much larger sample, of the order of 1,564 subjects calculated from the results of this study, would be needed to observe a statistically significant association between plaque, gingivitis, and bacteremia.

A further concern is the role of bacteremia from home care procedures in the etiology of BE. One group of investigators found that a group of children, some of whom suffered from cardiac problems, had gingival inflammation with little discernible bacterial dental plaque. It transpired that the children, who were being visited at home, had brushed their teeth just before the dentist arrived to carry out the examination,[21] and that is the possible explanation for the relatively small number of cases of BE following dental treatment.

Currently, there is very little reliable data on the intensity of bacteremia in humans. The existing data from animal studies indicate that the intensity of bacteremia is of the order of 1 x 10^6 – 1 x 10^8 colony forming units (cfus) per ml of blood.[22,23] The available data for humans demonstrates the intensity of bacteremia to vary from 1 cfu per ml of blood[24] to 240 cfus per ml of blood.[25] In the present study, the intensity ranged from 0 to 1666 cfus per ml of blood. At present, there is no advice available from the national advisory bodies regarding the intensity of bacteremia that "causes" endocarditis.

Conclusions

The implications of this data for endocarditis prophylaxis are clear. First, home care procedures should be practiced thoroughly and frequently to reduce the risk of bacteremia from tooth brushing.[7] Second, even the professional cleaning procedures with a rubber cup and scaling should be carried out with benefit of pre-procedure antibiotic prophylaxis. This is in line with guidelines published by the AHA.[3]

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Table 4. Bacteria Detected Following Cleaning Procedures in Children

BACTEC		ISOLATOR	
Aerobic	**Anaerobic**	**Aerobic**	**Anaerobic**
	Control (no cleaning procedures)		
S.sanguis Coagulase–negative staphylococci *Oerskovia* species	Coagulase – negative staphylococci		
	8.0% positive (4 of 50)		
1. Toothbrushing			
S. sanguis *S. sanguis*	*S. sanguis* *S. sanguis* *Veillonella* species		
S. acidominimus *Lactococcus cremori* Gram negative bacilli	*S. acidominimus* Gram positive cocci *Streptococcus* species *Streptococcus* species	Gram positive bacilli	
Gram negative bacilli Neisseria species 'Viridans' streptococci 'Viridans' streptococci Neisseria species Coagulase-negative staphylococci Neisseria species 'Viridans' streptococci 'Viridans' streptococci	Gram negative bacilli Neisseria species		
S. sanguis		Coagulase-negative staphylococci	
Neisseria species 'Viridans' streptococci	Neisseria species 'Viridans' streptococci		
	39.0% positive (20 of 52)		
2. Polishing teeth			
'Viridans' streptococci 'Viridans' streptococci	'Viridans' streptococci 'Viridans' streptococci	*Streptococcus* species Corynebacterium spp. Neisseria spp.	
S. bovis Neisseria spp. Corynebacterium spp. *S. milleri* 'Viridans' streptococci Gram positive bacilli Gram positive bacilli 'Viridans' streptococci *S. sanguis* Neisseria pharyngis *S. sanguis* Diphtheroids	Gram positive cocci Gram positive bacilli *S. sanguis* Corynebacterium spp. 'Viridans' streptococci Corynebacterium spp.	Gram positive bacilli *S. aureus*	
	25.0% positive (13 of 53, BACTEC only)		

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Continued~Table 4. Bacteria Detected Following Cleaning Procedures in Children

BACTEC		ISOLATOR	
Aerobic	**Anaerobic**	**Aerobic**	**Anaerobic**
	Control (no cleaning procedures)		
3. Scaling			
		S. sanguis	
		S. mitis	
Neisseria spp.	'Viridans' streptococci		
Streptococcus spp.			
	Gram negative bacilli	Diphtheroids	
Coagulase negative	Coagulase-negative		
staphylococci	staphylococci		
'Viridans' streptococci			
Veillonella spp.	Gram negative rods		
Gram negative rods			
S. sanguis	*S. sanguis*		
	Coagulase-negative staphylococci		
	'Viridans' streptococci		
	Peptostreptococcus		
'Viridans' streptococci			
'Viridans' streptococci			
'Viridans' streptococci			
Neisseria spp.			
S. mitis			
'Viridans' streptococci	Viridans' streptococci	Gram negative bacilli	
Neisseria sp.			
		'Viridans' streptococci	
'Viridans' streptococci	'Viridans' streptococci		
Neisseria spp.			
'Viridans' streptococci			
40.0% positive (20 of 50, BACTEC only)			

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